

# Data fusion of High Resolution X-ray CT and SEM/EDS for pseudo-3D elemental and structural characterization of the Vosges sandstone.

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## ABSTRACT

Although High Resolution X-ray CT (HRXCT/ $\mu$ -CT) has become an invaluable tool for the 3D characterization of many materials, including natural stones [1], the technique suffers from some important limitations. A first shortfall of HRXCT is the limitation of resolution; although high-end X-ray tubes have a focal spot size of 400 nm (and therefore can deliver images with this spatial resolution), the sample size has to be extremely small (in the order of 1 mm diameter). This leads to questions about the representative elementary volume, not in the least for heterogeneous geological samples [2]. Secondly, the lack of chemical information in HRXCT datasets is a big miss for geologists, as not only structure of rocks is of importance, but mineralogy also plays a big role in various processes that happen in the pore space of these materials. These processes include migration of (saline or acid) fluids [3], dissolution and precipitation [4].

Focussed Ion Beam combined with Scanning Electron Microscopy (FIB/SEM) makes it possible to acquire high resolution 3D structural information, combined with elemental analysis using Electron Dispersive Spectroscopy (EDS). However, FIB/SEM is very time consuming and the analysed volume is very small (up to several  $10^3 \mu\text{m}^3$ ). Especially the first factor, combined with limited availability of FIB/SEM equipment, make the technique very expensive.

The Vosges sandstone is a clay rich sandstone consisting of 75 % quartz, 10 % micas and other clay minerals, and 15 % (weathered) feldspars. Quartz grains can easily be analysed using HRXCT since the grain size is about 150 - 450  $\mu\text{m}$ . However, the fine-grained clayey minerals appear as thin layers throughout the stone, causing the stone to swell and shrink under different environmental conditions. Hence, the location and structure of these clays is essential for the understanding of the stone's behaviour, meaning higher resolution and elemental analysis are a necessity. In addition to this, the irregular spacing and thickness of these layers implies a sample size of about 1 cm, is big enough to be representative for the material.

To analyse the samples both chemically and structurally, HRXCT is carried out on  $5\text{-}10^3 \text{ mm}^3$  cubic samples with polished sides, for the analysis of the overall structure of the Vosges sandstone. Next, all six sides of the cube are analysed with SEM/EDS, allowing 2D image registration of these data on the sides of the 3D cubes. Extrapolation of the information at the side-planes provides additional information about structures and elements in the interior of the stone.

## REFERENCES

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